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Observational study

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Abstract

Background and aims: Musculoskeletal pain may negatively affect work ability, especially when work demands are high and/or physical capacity of the worker is low. This study investigated the association between intensity of musculoskeletal pain in multiple body regions and work ability among young and old workers with sedentary and physical demanding jobs.

Methods: Currently employed wage earners ($n = 10{,}427$) replied to questions about pain intensity, work ability, and physical work demands. The odds ratio (OR) for having a lower level of work ability in relation to the physical demands at work were modeled using logistic regression controlled for various confounders.

Results: The OR for lower work ability increased with higher pain intensity in all regions among workers with sedentary and physical work. The same pattern was observed among workers <50 years and ≥50 years in both work types. The association was quite consistent across age and work activity groups, although it tended to be more pronounced among those with physically demanding work in some of pain regions.

Conclusions: This study shows that increasing pain intensity in multiple sites of the body is associated with lower work ability. This was seen for both younger and older workers as well as those with sedentary and physical work.

Implications: Physical workers with multiple-site pain may especially be at increased risk of the consequences of reduced work ability. Therefore, extra attention is needed and this group may benefit from better targeted preventive measures.

Keywords: musculoskeletal pain; work ability; sedentary workers; physical workers; job demands.

1 Introduction

Musculoskeletal disorders are associated with increased levels of sickness absence, productivity loss, and early retirement and can be costly for the individual, workplaces and society [1–3]. The consequences of multi-site pain seem to be worse than those of single-site pain [4]. For instance, a study from the Netherlands found that the functional consequences of pain depend on how many body regions are affected, i.e. the more widespread pain, the higher the likelihood of medical consumption, sickness absence and restricted work [5]. Altogether, regardless of pain location, persons experiencing pain in more than one body site consistently perceive a greater impact on daily function and quality of life and greater risk of a poor prognosis including, in general, poorer response to treatment [6, 7].

Musculoskeletal pain can also influence work, e.g. expressed as reduced work ability [1]. Work ability reflects the balance between personal resources and job demands and is defined as the degree to which a worker, given his

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health, is physically and mentally able to cope with the demands at work [2, 8]. Workers with high work ability index scores have a lower risk for early retirement and a higher quality of life-even after retirement [9]. Moreover, epidemiologic studies have found that multi-site pain is associated with poor work ability [10]. A prospective study showed that multisite pain strongly predicts poor work ability among industrial workers [11]. However, some studies have found that although multi-site pain is common among the working population and associated with decreased work ability, a considerable proportion of workers with musculoskeletal pain may not have impaired work ability [12].

Previous cross-sectional studies and a recent systematic review show that both low personal resources, e.g. musculoskeletal pain, and demanding working conditions, e.g. high physical workload are associated with decreased work ability [13–15]. Besides high physical work and pain intensity, individual factors like older age have also been associated with poor work ability [16, 17]. A more recent cross-sectional study showed that age is significantly and negatively associated with work ability [18]. Moreover, studies have reported that the association between physical work demands and work ability is stronger among workers closer to retirement then among younger workers [1].

Although there is evidence that musculoskeletal pain is a risk factor for lower work ability [4, 10, 19], there is still a lack of studies that have investigated the association of multi-site pain intensity with lower work ability in relation to physical activities at work and in different age groups. Therefore, whether the consequences of multi-site pain – in terms of lower work ability – are higher among older workers and those with physically demanding work remains unknown and studying about that will contribute to a better knowledge of the musculoskeletal complaints reported by general working population and help us to tailor vocational rehabilitation programs that prevent unneeded work disability and maintain work performance.

The purpose of this study was to investigate the association between musculoskeletal pain intensity in multiple regions of the body and work ability among young and old workers with sedentary and physical demanding jobs.

2 Methods

2.1 Study design and setting

The present cross-sectional study employs data from the 2010 round of the Danish Work Environment Cohort Study (DWECS) [20]. The specific questions used for this study are specified below. The reporting of this study conforms to the guideline "Strengthening the Reporting of Observational Studies in Epidemiology" (STROBE) [21].

2.2 Ethics

This study has been reported to and registered by Datatilsynet (the Danish Data Protection Agency; journal number 2007-54-0059). According to the Danish law, questionnaires and register-based studies do not need approval by ethical and scientific committees, nor informed consent [22]. All data were de-identified and analyzed anonymously.

2.3 Participants

The questionnaire used in the present study was sent to approximately 20,000 Danish workers, where a total of 10,605 (approx. 53%) responded [23]. In this study, we included only currently employed wage earners (n = 10,427), i.e. excluding self-employed people and people not affiliated with the labor market. Not all participants filled in all survey questions, whereas the exact number for each analysis varies. Demographics and lifestyle characteristics of the study population are reported in Table 1.

2.4 Outcome variable work ability

Work ability in relation to physical demands of the job was assessed by the single-item question "How do you rate your current work ability with respect to the physical demands of your work?". Studies have shown that the work ability score question has good validity and reliability when compared with the total WAI [24, 25]. Respondents were asked to reply on a five-point Likert-scale: excellent, very good, good, fair, or poor. Subsequently, these responses were converted to a scale of 0–100, with 0 being poor and 100 being excellent, i.e. excellent (100 points), very good (75 points), good (50 points), fair (25 points) and poor (0 points) [23]. Therefore, for data analyzing, the work ability considered as a dichotomous variable with two categories and the cut-off point was 25:

- Poor and fair (low work ability = 0–25 points)
- Good, very good and excellent (high work ability = more than 25 points)

Table 1: Demographics and lifestyle characteristics.

	n	Mean	SD	%
Age (years)	10,427	43.5	11.7	
Gender				
Men	4,762			45.7
Women	5,665			54.3
BMI				
Underweight	86			0.9
Normal	5,319			52.7
Overweight	3,399			33.7
Obese	1,291			12.8
Smoking				
No, never	4,897			48.2
Ex-smoker	2,916			28.7
Yes	2,356			23.2
Physical activity at work				
Sedentary work	4,744			46.9
Physical work	5,377			53.1
Work ability				
Pretty bad	682			6.75
Good, very good and excellent	9,429			93.25

BMI = body mass index ($kg \cdot m^{-2}$).

2.5 Explanatory variables

2.5.1 Musculoskeletal pain

Pain intensity in the low back, neck-shoulder, and arm (including hands, forearm, and elbow) was assessed for each region as average pain during the last 12 months on a scale of 0–9, where 0 is no pain and 9 is worst pain. The question was phrased as "trouble (pain or discomfort)." [26]. For further analyses, pain in the three regions was averaged and thereafter dichotomized into "High pain" (pain intensity ≥6), "Moderate pain" (pain intensity 3–5), "No or little pain" (pain intensity 0–2).

2.5.2 Physical activity at work

Participants were divided into either sedentary work or physically demanding work based on their answers to the following question: "How will you describe your physical activity in your main profession?" [23]. Sedentary workers represent those, who filled out the sub-question: "Mostly sedentary work that does not require physical exertion". Participants were allocated as having physically demanding work if they filled out one of the following three sub-questions regarding their physical activity in their profession: "Mostly standing or walking work that otherwise does not require physical exertion", "Standing or walking work with some lifting- or bearing tasks", or "Heavy or fast work, which is physically demanding".

2.5.3 Control variables

The analyses were controlled for the following variables: gender (categorical), age (continuous), smoking status (categorical; "No, never", "Ex-smoker" and "Yes"), body mass index (BMI, categorical; underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight [≥25.0 kg/m^2), obese (>30.0 kg/m^2)] [27], psychosocial work factors (continuous; emotional demands and influence at work) from the Copenhagen Psychosocial Questionnaire (COPSOQ) [28], and chronic disease (categorical). Chronic disease was determined from the question, "Has a doctor ever told you that you have or have had one or more of the following diseases?" with the response options being "Yes" and "No, never" to the following diseases: depression, asthma, diabetes (all types), cardiovascular disease, and cancer. These control variables were included because they may be associated with both musculoskeletal pain and work ability.

2.5.4 Statistical analysis

All statistical analyses were performed using the SAS statistical software for Windows (SAS Institute, Cary, NC, USA). Using logistic regression analyses, we estimated the association between work ability (dependent variable) and multi-site pain (independent variable). Analyses were performed stratified for work type (sedentary and physical), and additionally for workers <50 years and ≥50 years in both sedentary and physical work. We used logistic regression analyses because the outcome was made dichotomous and all analyses were adjusted for the control variables mentioned above. An alpha level of <0.05 was accepted as statistically significant. Results are reported as OR's and (95% confidence intervals) unless otherwise stated.

3 Results

Table 1 shows demographics, lifestyle, and work-related characteristics. Among the total population of wage earners, 46.9% were engaged in sedentary work, 53.1% performed physical work. Tables 2–5 show the odds ratio (OR) estimates for having a lower level of work ability in

Table 2: Work ability in relation to average pain intensity among those with seated and physical work, respectively.

Age-group	Pain	*n*	%	Seated work OR (95% CI)	*n*	%	Physical work OR (95% CI)
All	Low	3,232	69.1	1	3,302	62.4	1
	Moderate	1,265	27.0	4.4 (2.9–6.7)	1,629	30.8	3.8 (2.9–4.9)
	High	183	3.9	14.9 (8.9–25.2)	362	6.8	15.7 (11.5–21.3)
<50 years	Low	2,154	71.1	1	2,232	65.3	1
	Moderate	783	25.8	5.5 (3.2–9.5)	982	28.7	3.9 (2.8–5.6)
	High	93	3.1	16.9 (8.1–35.2)	203	5.9	19.1 (12.5–29.2)
≥50 years	Low	1,078	65.3	1	1,070	57.0	1
	Moderate	482	29.2	3.3 (1.7–6.3)	647	34.5	3.6 (2.5–5.3)
	High	90	5.5	13.2 (6.2–28.1)	159	8.5	13.6 (8.6–21.5)

Table 3: Work ability in relation to neck-shoulder pain intensity among those with seated and physical work, respectively.

Age-group	Pain	*n*	%	Seated work OR (95% CI)	*n*	%	Physical work OR (95% CI)
All	Low	2,643	56.6	1	2,834	53.7	1
	Moderate	1,411	30.2	2.5 (1.5–3.9)	1,712	32.4	2.2 (1.7–2.9)
	High	615	13.2	8.7 (5.5–13.7)	731	13.9	7.7 (5.9–10.2)
<50 years	Low	1,739	57.5	1	1,894	55.6	1
	Moderate	868	28.7	2.7 (1.5–5.0)	1,066	31.3	2.6 (1.8–3.8)
	High	415	13.7	7.8 (4.2–14.3)	449	13.2	9.0 (6.1–13.1)
≥50 years	Low	904	54.9	1	940	50.3	1
	Moderate	543	33.0	2.3 (1.1–4.8)	646	34.6	1.8 (1.3–2.7)
	High	200	12.1	10.8 (5.3–22.0)	282	15.1	6.7 (4.5–10.0)

Table 4: Work ability in relation to low back pain intensity among those with seated and physical work, respectively.

Age-group	Pain	*n*	%	Seated work OR (95% CI)	*n*	%	Physical work OR (95% CI)
All	Low	3,012	64.4	1	2,832	53.7	1
	Moderate	1,124	24.0	1.5 (0.9–2.3)	1,549	29.4	2.1 (1.6–2.7)
	High	540	11.6	6.8 (4.6–10.2)	896	17.0	5.9 (4.6–7.7)
<50 years	Low	2,008	66.3	1	1,868	54.8	1
	Moderate	714	23.6	1.3 (0.7–2.5)	958	28.1	1.8 (1.2–2.6)
	High	305	10.1	6.8 (4.0–11.6)	580	17.0	5.5 (3.9–7.8)
≥50 years	Low	1,004	60.9	1	964	51.5	1
	Moderate	410	24.9	1.7 (0.8–3.6)	591	31.6	2.6 (1.7–3.8)
	High	235	14.3	7.3 (3.9–13.8)	316	16.9	6.8 (4.5–10.2)

Table 5: Work ability in relation to arm-hand pain intensity among those with seated and physical work, respectively.

Age-group	Pain	*n*	%	Seated work OR (95% CI)	*n*	%	Physical work OR (95% CI)
All	Low	3,590	76.9	1	3,823	72.4	1
	Moderate	763	16.3	2.4 (1.6–3.6)	971	18.4	2.7 (2.1–3.5)
	High	318	6.8	4.7 (3.0–7.4)	484	9.2	6.2 (4.8–8.1)
<50 years	Low	2,395	79.2	1	2,618	76.8	1
	Moderate	445	14.7	2.7 (1.6–4.6)	539	15.8	3.4 (2.4–4.8)
	High	184	6.1	4.8 (2.6–9.0)	250	7.3	7.0 (4.8–10.2)
≥50 years	Low	1,195	72.6	1	1,205	64.4	1
	Moderate	318	19.3	2.1 (1.2–4.0)	432	23.1	2.2 (1.5–3.2)
	High	134	8.1	4.6 (2.4–8.9)	234	12.5	5.8 (3.9–8.5)

relation to pain intensity among workers with sedentary and physical work, and additionally for workers <50 years and ≥50 years in both work types. The odds increased as a function of pain intensity in all regions among workers with sedentary and physical work. The same pattern was observed among workers <50 years and ≥50 years in both work types. Moreover, although not significantly different, the odds of having lower work ability in relation to high average pain intensity were higher among workers with physical work than workers with sedentary work and in workers <50 years than workers ≥50 year as well (Table 2). Also the percentage of physical workers who affected by high average pain intensity in three sites of body is higher in the older workers (8.5%) than the youngers (5.9%).

Table 3 shows that among workers with sedentary and physical work, work ability was associated with both moderate and high pain intensity in the neck and shoulder region. The numerically highest odds ratio was in the workers with sedentary work who are >50 years and have high pain intensity in the neck and shoulder region.

Table 4 shows that for workers with sedentary work, work ability was only associated with high pain intensity in the low back region [OR, 6.8 (95% CI 4.6–10.2)]. Also, among individuals with mainly physical work, work ability was associated with both moderate [OR, 2.1 (95% CI 1.5–2.9)] and high pain intensity [OR, 6.2 (95% CI 4.5–8.6)]. The analysis of age in both sedentary and physical work shows that odds of having lower work ability in relation to low back pain intensity were higher among workers ≥50 years than workers <50 year. However, it is not a significant difference statistically. Also the percentage of workers who affected by high pain intensity in low back is higher in the physical workers (17%) than sedentary workers (11.6%).

Table 5 shows that among individuals with both sedentary and physical work, work ability was associated with moderate and high pain intensity in arm region. Although the odds ratio among both sedentary and physical work was higher in workers <50 years than workers ≥50 years, that's not a significantly difference.

4 Discussion

Pain intensity in multiple sites of the body was generally associated with lower work ability in relation to the physical demands of the job. The association was quite consistent across age and work activity groups, although it tended to be more pronounced among those with physically demanding work.

As expected, we found that pain intensity in the neck/shoulder, arm, and low back was associated with lower level of work ability. The findings of this study support the results from several previous studies [4, 10, 11, 16, 19]. Phongamwong and Deema showed that multi-site musculoskeletal pain had an association with poor work ability and the magnitude of association was likely to increase by a higher number of pain sites [10, 29]. Also, an earlier cross-sectional study among a sample of the general population in Finland indicated that multi-site pain was strongly associated with reduced work ability [16]. It seems the consequences of pain can affect the work performance and lead to decrease work ability in general workers with different groups of ages and work demands.

The OR of having low work ability was not significantly different from those with sedentary work to workers with physical demanding work. However, that tended to be more pronounced among those with physically demanding work especially, in high average pain intensity of three regions of body and upper extremity region. Although some of the previous studies showed that reduced work ability has been associated with high physical workload [15, 29, 30], there are some studies that found the decline in work ability connected with multi-site pain was not increased by exposure to adverse physical factors at work [11]. This may be a preventive mechanism where musculoskeletal pain affects a person's physical function, which will reduce engagement in physically heavy work in order to avoid pain [13]. Thus, work situations with high physical work load that potentially can induce pain may prevent loss of workability among workers with multi-sited pain. Also, it seems the consequences of multisite pain are more detrimental to work performance as a whole and are not different among physical workers compared with sedentary workers. In accordance, some previous studies showed that several potentially modifiable factors related to health, work, and lifestyle were associated with good work ability among occupationally active subjects with MSP [12]. This may explain why we did not find a significant difference between work ability among workers with physically demanding work and those with sedentary work.

The results showed that the OR of low work ability was not significant in relation to moderate low back pain intensity among sedentary workers while that was significant among physical workers. It could be speculated that moderate low back pain is not of major importance for sedentary workers because they usually sit in the most of time at work and that may not effect on their work performance. In contrast, even moderate low back pain intensity as well as the high low back pain intensity can

affect the work performance and result in the lower level of work ability among workers with physical demands. Interestingly, that did not happen for sedentary workers on the pain intensity in the other regions of the body. Thus it seems that even moderate pain intensity in neck-shoulder and/or arm-hand regions can affect the work performance of sedentary workers in some tasks that they have to use their arm, despite of being in the sitting position.

Another finding of the present study is that the association between pain intensity and work ability in relation to work demands was not significantly different between younger and older workers. Previous studies have shown that older workers are more affected by physical work demands compared with younger workers [1, 2]. Thus, our results may simply reflect that both musculoskeletal pain and work ability are affected negatively by physically demanding work, and that a large part of the detrimental effect of physically demanding work on work ability is mediated through increased pain. Thus, a slightly higher percentage of workers with physically demanding work compared to those with sedentary work, had higher levels of musculoskeletal pain. However, in a prospective study, Feldt et al. observed that in patients whose work ability was excellent or good, the average exit age from the labor market was 61.3 years, i.e. significantly higher than in patients whose work ability was weak [31]. This contradiction in the results of various studies may be due to individual differences in the subjects.

There are strengths as well as weaknesses to our study. The main strength is the representative sample of the entire Danish working population without selection bias and with a high response rate [20]. The question about work ability in relation to physical demands was a single item from the validated and internationally recognized work ability index (WAI) questionnaire [23, 32]. We decided not to use the entire validated WAI which has seven items, because the question used in the present study has previously shown a strong association and an equally good predictive value with regard to sick leave, health, age, job content, and reported pain as the entire WAI [24, 25]. There are some limitations in our study. The main limitation is the cross-sectional study design that excludes the possibility to examine temporal relationships of the variables and hence to make causal inferences. Also, of concern is the potential bias caused by those who refused to participate as well as those who refused to respond to questions. Moreover, data from self-assessments are often criticized with respect to precision, commonly resulting in increased risk of bias due to overestimation or underestimation of exposure levels.

5 Conclusion

This study shows that increasing pain intensity in multiple sites of the body is associated with lower work ability in the general working population. The association was quite consistent across age and work activity groups, although it tended to be more pronounced among those with physically demanding work. Thus, physical workers with pain in multiple body sites may especially be at increased risk of the consequences of reduced work ability, e.g. sickness absence, productivity loss and early retirement. Moreover, it can be costly for the individual, workplaces, and society. Therefore, extra attention is needed and this group may benefit from better targeted preventive measures. Also, considering this association, future studies should investigate whether performing exercises or ergonomic solutions in the work environment can affect in increasing work ability, for individuals with pain in multiple regions and mainly physical work.

Authors' statements
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